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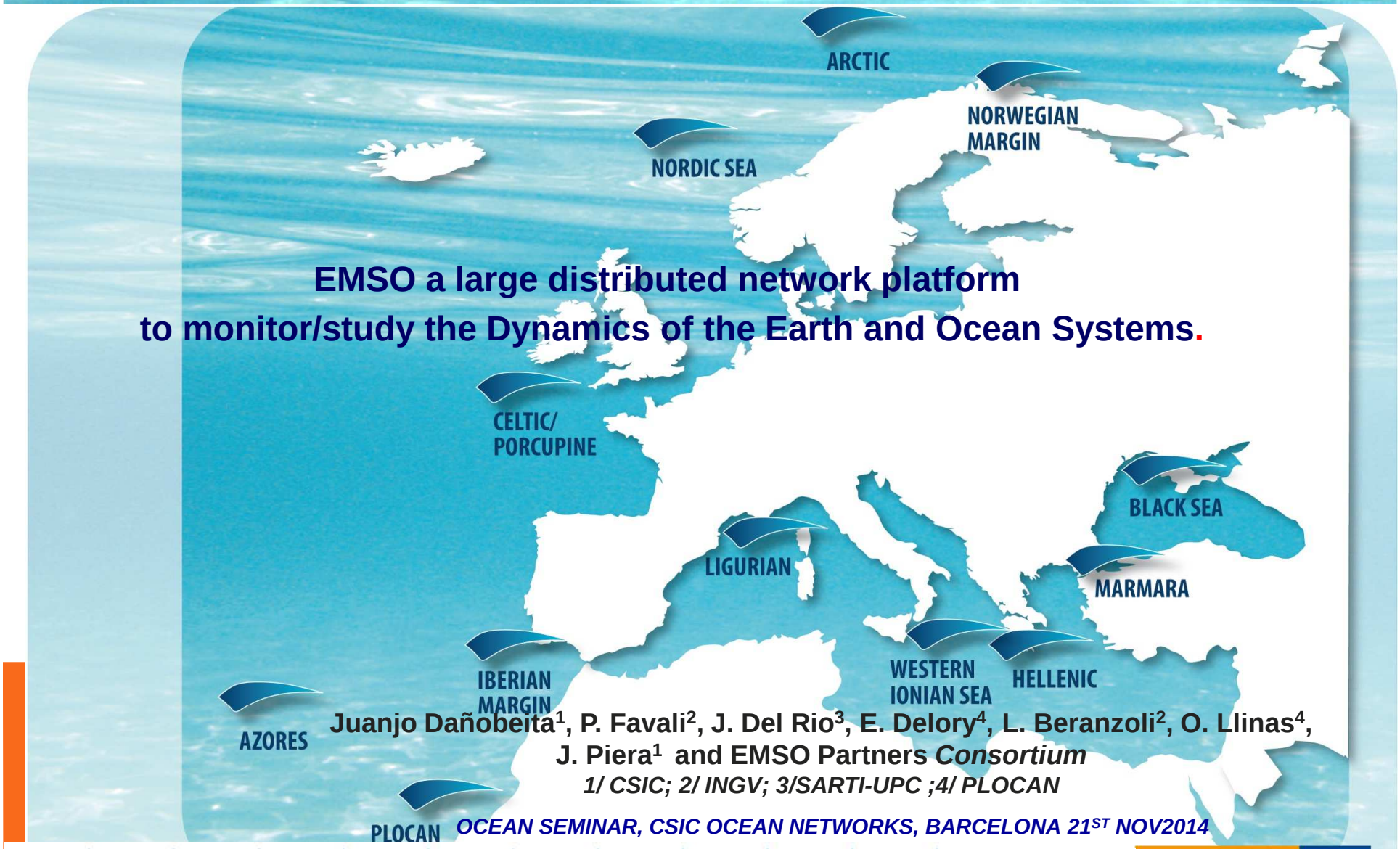

EMSO a large distributed network platform to monitor/study the Dynamics of the Earth and Ocean Systems.

Juanjo Dañobeita[1], P. Favali[2], J. Del Rio[3], E. Delory[4], L. Beranzoli[2], O. Llinas[4], J. Piera[1] and EMSO Partners *Consortium*

1/ CSIC; 2/ INGV; 3/SARTI-UPC ;4/ PLOCAN

OCEAN SEMINAR, CSIC OCEAN NETWORKS, BARCELONA 21ST NOV2014

European Strategy Forum on Research Infrastructures ESFRI

EMSO is a Distributed European Research Infrastructure of fixed seafloor and water column observatories constituting a Large Scale infrastructure for long-term monitoring of marine environmental processes

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Challenging Topics

- **Health of the Oceans; Ocean Circulation, warming and acidification**
- **Marine resources exploitation impact and sustainability**
- **Natural Hazards; Early warning of tsunami & earthquakes**

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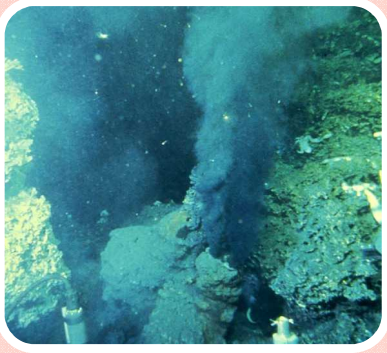
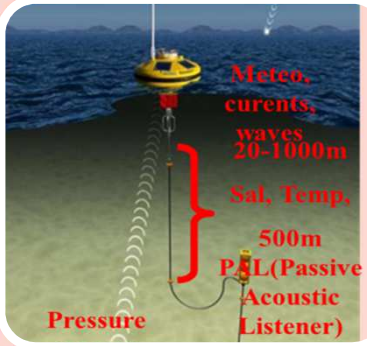
SCIENTIFIC RESEARCH OBJECTIVES





Geosciences

Seismicity

Gas hydrate stability

Seabed fluid flow

Submarine landslides

Submarine volcanism

Geo-hazard early warning

Physical Oceanography

Ocean warming

Deep-ocean circulation

Benthic and water column interactions

Marine forecasting

Biogeochemistry

Ocean acidification & Solubility pump

Biological pump

Hypoxia

Continental shelf pump

Deep-ocean biogeochemical fluxes

Marine Ecology

Climate forcing of ecosystems

Molecules to microbes

Fisheries

Marine noise

Deep biosphere

Chemosynthetic ecology

Opportunities exists through **EMSO- ERIC** consortium

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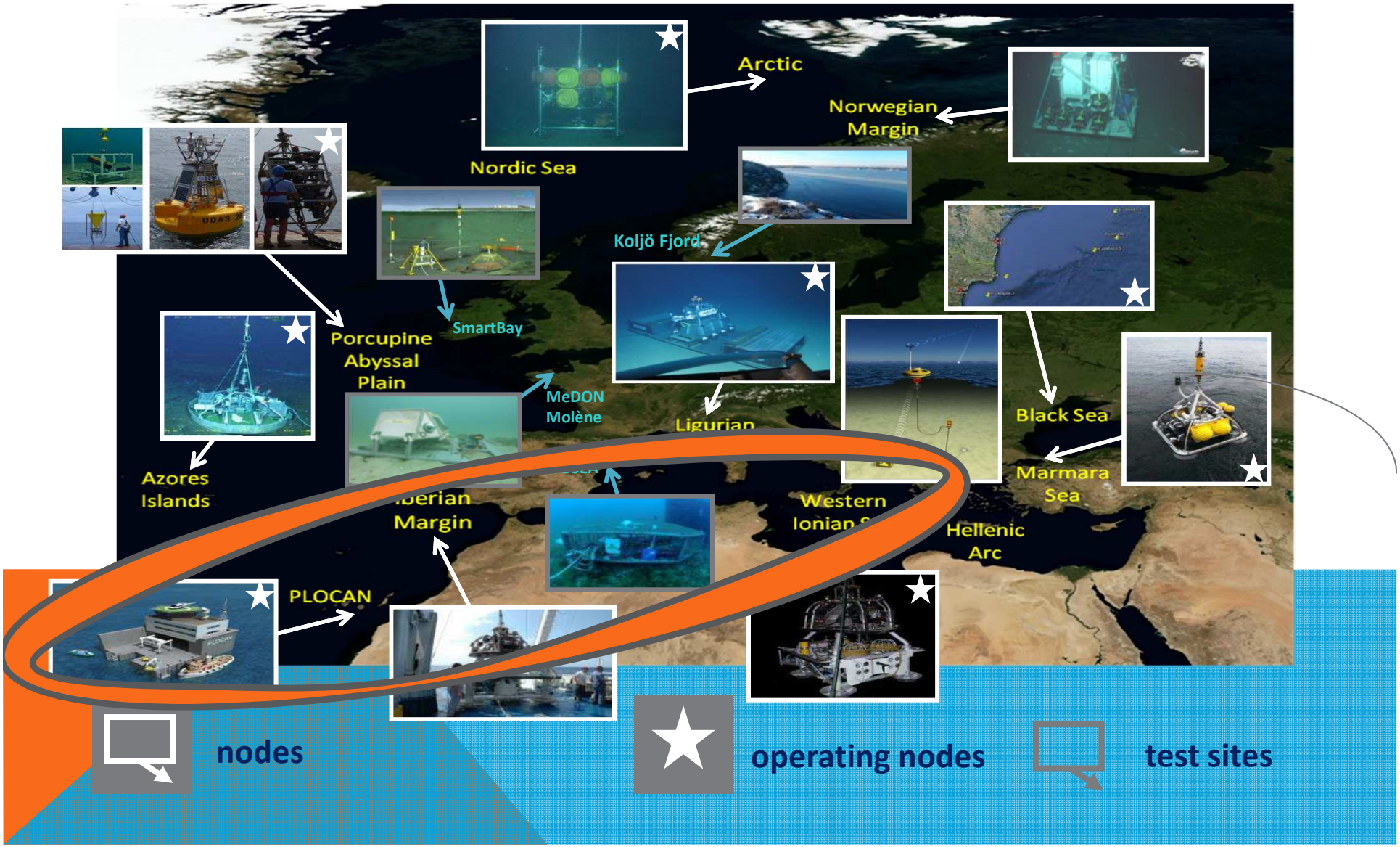
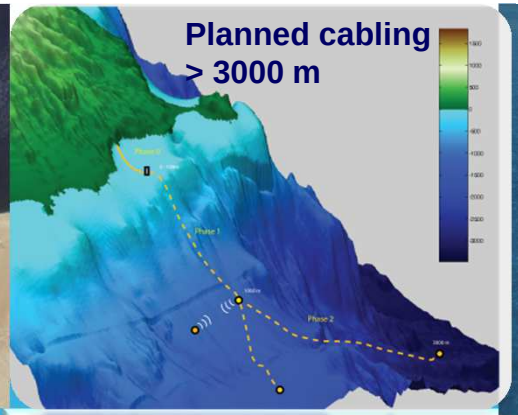
EMSO nodes – present status



PLOCAN OBSERVATORY (NE ATLANTIC Emso-site)

- **Regional Observatory (PLOCAN-ESTOC)**
- **Open-ocean surface,** from midwater to deep seafloor within an Intraplate active volcanism
- **Coastal Observatory (**1st phase: secured funds for optical fiber cable down to 100 m, 4km offshore, for deeper water is planned)
- **Mobile Observatory** (3 gliders ready to operate to regional station, down to 1500 m depth)

PLOCAN Location at 50 m; Regional Site ESTOC at 3670 m



PLOCAN Planned implementation phases down to 3000 m

Platform construction contract signed (rendering of the platform)

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CURRENT STATUS

Large Facilities and equipment pool

Surface and Midwater

Hosting: Buoys and moorings can host additional instrumentation for atmospheric and air-sea interface, and autonomous systems (real-time communication between midwater and surface under implementation) respectively. Clamp systems and other mechanical adapters can be manufactured locally upon request. Satellite link is Argos 3. More information on the station is available on the web site.

Data: Atmosphere: Wind, temperature, humidity, pressure, solar radiation Ocean-Air interface: pH, CO_2, Chl-a, salinity, temperature, dissolved oxygen Water column: Salinity, temperature, nutrients, current, etc.

Deep Seafloor

Any autonomous system can be deployed on the seafloor from the yearly campaign of R/V **Sarmiento de Gamboa** (large systems) or R/V **Ignacio Lozano** small operations. Ports for deep sea communication with surface via acoustic modem are planned.
Data: Tremors, seismicity and acoustics (10Hz-6kHz), salinity, temperature delayed mode data (real-time planned)

OBSEA
EXPANDABLE SEAFLOOR OBSERVATORY

SARTI UPC

european multidisciplinary seafloor & water column observatory
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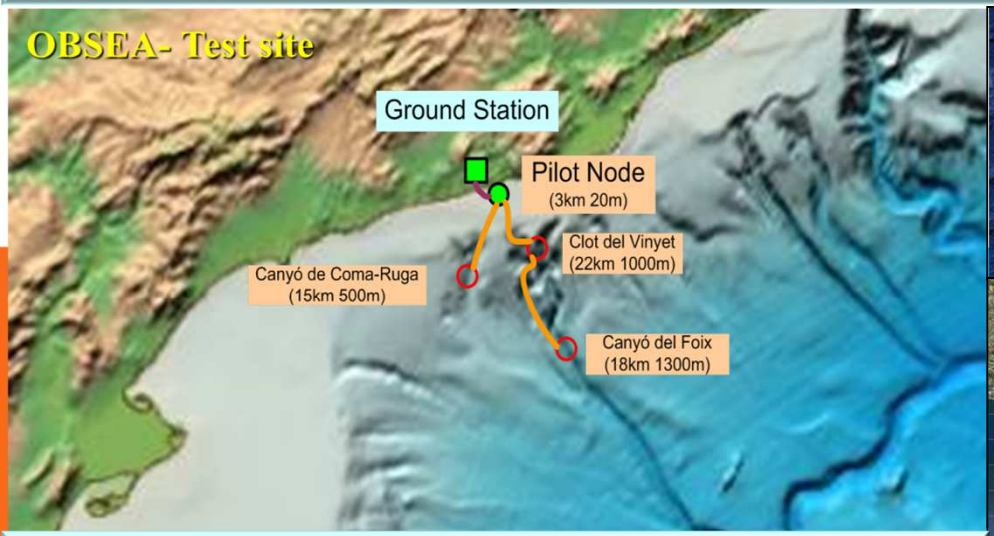
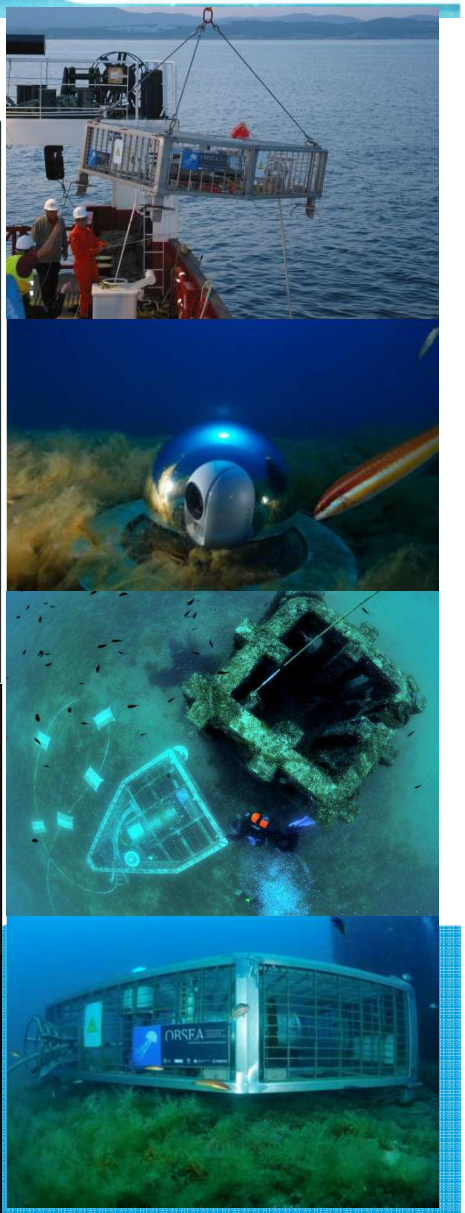
OBSEA (W Mediterranean EMSO - Test site)

- **Coastal cabled seafloor** observatory 4 km offshore Vilanova I la Geltru (Barcelona, Spain) at 20 m depth within a fishing protected area. Accessible by scuba divers and small boats during the whole year.
- **Operational with 16 wetmate** connectors for instrumentation (power, communications, synchronization. Powered by AC/DC converter 320 VDC-11A.
- **Labeled Test-site** of the European ESONET & EMSO projects
- **Expandable to deep seafloor** observatory network that covers several remarkable deep sea canyons. Every node will provide connectivity to several instruments (at least 8) as well as a link to other nodes.
- **Current Underwater instruments (**frame protected**):** CTD, seismometer, ADCP, hydrophone, pH, video camera. Surface buoy: meteo station, video camera.



Location Map of OBSEA Lab. Offshore Vilanova, and planned extended cables and nodes

OBSEA General view location



OBSEA
EXPANDABLE SEAFLOOR OBSERVATORY

SARTI UPC

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- **Possibility to deploy new instrumentation for testing: installation procedures, data communication, data management, performance, robustness, etc…**
- **Real-time access to data instrumentation.**

CSIC –INFRASTRUCTURE

- **RV Sarmiento de Gamboa** well equipped and experienced in seafloor operations with DP in deep-sea ROVS, cable deployment, and other tools and equipment.
- **A pool of up to 17 OBS** for acoustic/seismic surveillance, as marine mammals passage, volcanic instabilities or massive slides (Geohazard).
- **Current instruments:** Deep & shallow Multibeam, SBP, CTD, Heavy seismic, ADCP, compressors, Cranes, dry and wet labs. etc.,

RV Sarmiento de Gamboa

Multipurpose RV built 2007
Oceanic
Overall length: 70 meters
Crew 16 / Scientists 26
24 hours per day
A-frames /winches /cranes
8000 m depth deployed equipment
USBL u.p.s
D.P Class 1

OBS- Pool (17)

EMSO nodes types

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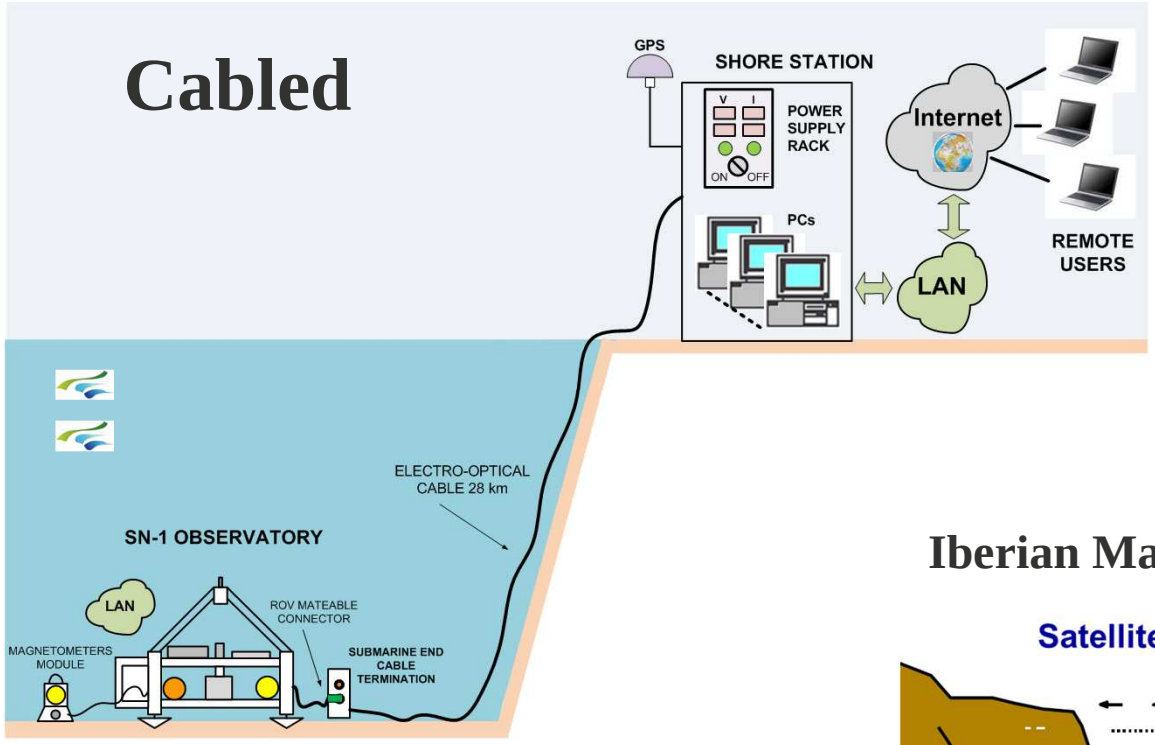
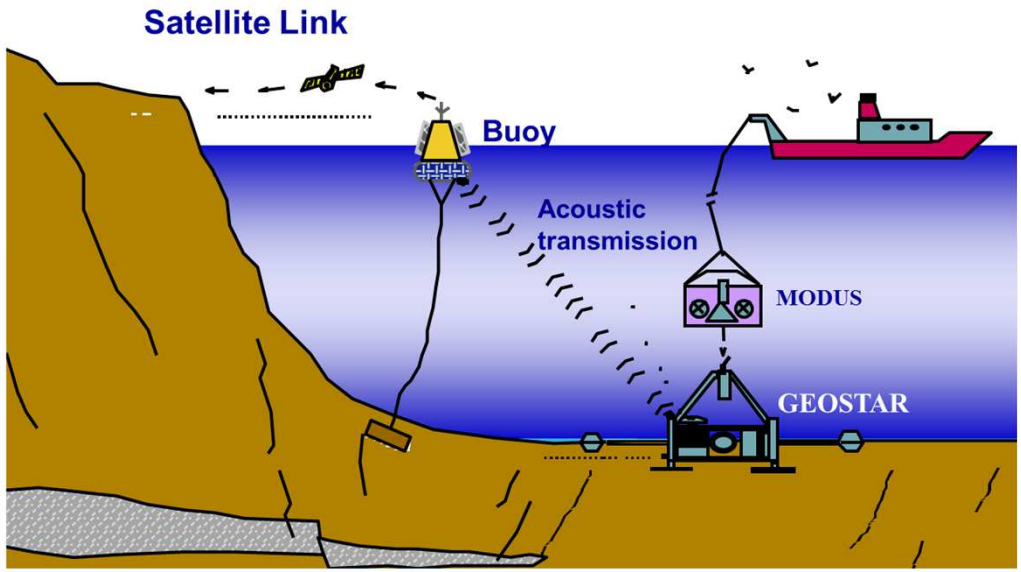
Cabled



Payload:
seismological, geomagnetic, gravimetric, oceanographic, hydro-acoustic, bio-acoustic

Standalone

Iberian Margin – NEAREST EC Project



Rationale for the missions:
i) characterise ambient noise (marine mammal sounds, environmental/anthropogenic sources);
ii) study earthquake and tsunami generation in Iberian Margin & Western Ionian Sea
Detection algorithm runs in the Shore Station

NEMO-SN1 & GEOSTAR

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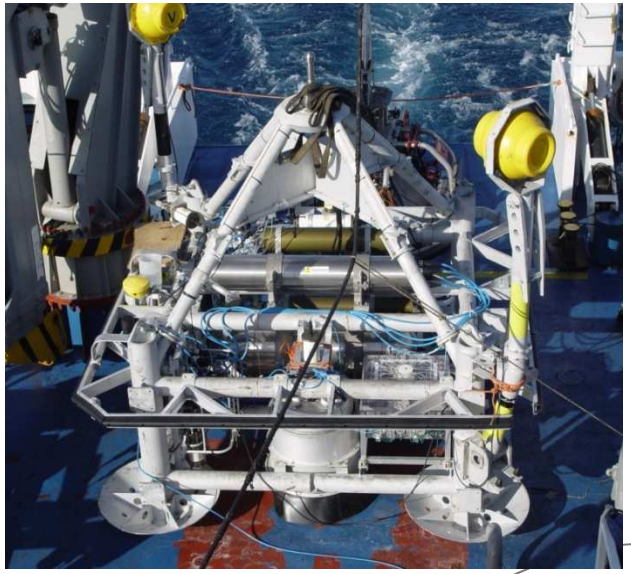

Two seafloor observatories were equipped with the tsunami detector

GEOSTAR (acoustic-linked)

SN-1 (cabled)

Common features

Multidisciplinary

Single, open frame, reconfigurable according to different mission requirements

4000 m design depth

Dedicated intervention system

- **Quick response time**: few minutes for the generated tsunami to reach the coast.
- **Tsunami warning**: real time pressure & seismic data analysis performed on the seafloor
- **Automatic transmission** of data through acoustic link and moored relay buoy

EMSO nodes: present status

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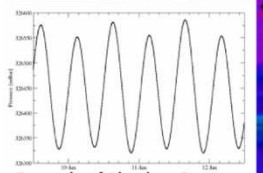
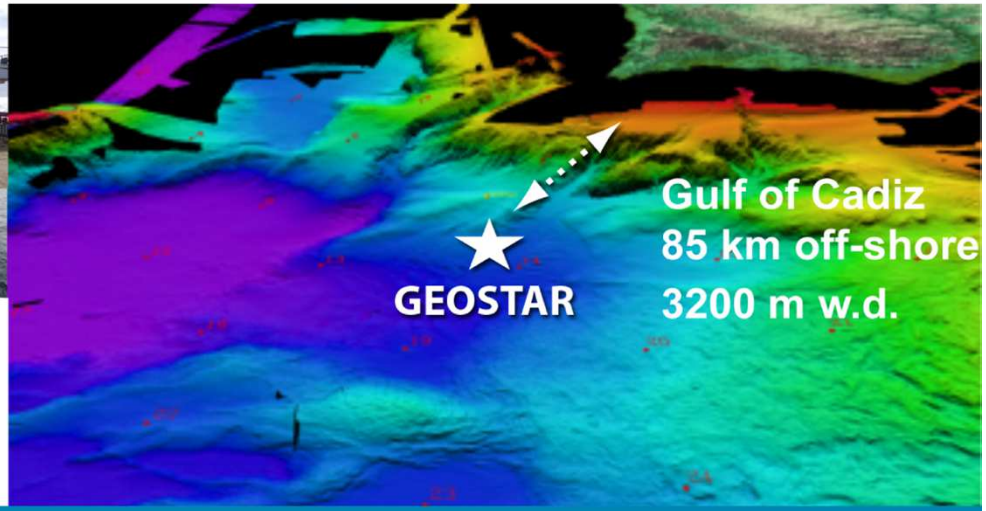
Gulf of Cadiz (Atlantic Ocean), source area of 1755 Tsunami which destroyed Lisbon and the coasts of South Portugal, Spain and Morocco



Example of Absolute Pressure Gauge raw data recorded



INFRASTRUCTURE GEOSTAR observatory, seafloor station with acoustic connection to a surface buoy and satellite connection from buoy to shore.

RESEARCH Eurasian and African plate boundary off Portuguese coast, Mud volcanoes, pockmarks, mud diapirs, carbonate chimneys, hydrocarbon venting and faulting; prototype tsunami meter; passive acoustics related to marine mammals and anthropogenic noise

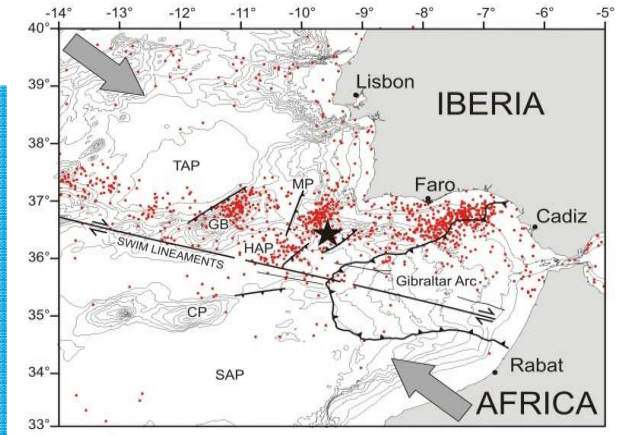
PREVIOUS/RECENT ACTIVITIES part of HERMIONE research; NEAREST and NEAMTWS geo-hazard early warning efforts; ESONET demo mission LIstening to the Deep Ocean environment (LIDO); near real-time data transmission trough acoustic link from seafloor observatory to surface buoy and through satellite link from buoy to shore based on **GEOSTAR** platform;

FUTURE ACTIVITIES Installation of an observatory starting in 2013, with communication by satellite link, in the same site or a neighbouring place

IBERIAN MARGIN

The abyssal observatory GEOSTAR, with the tsunamometer on board operated in an active seismic zone (3200 m)

Two missions
Aug 2007 – Aug 2008
Nov 2009 - Jun 2011



EMSO nodes: present status

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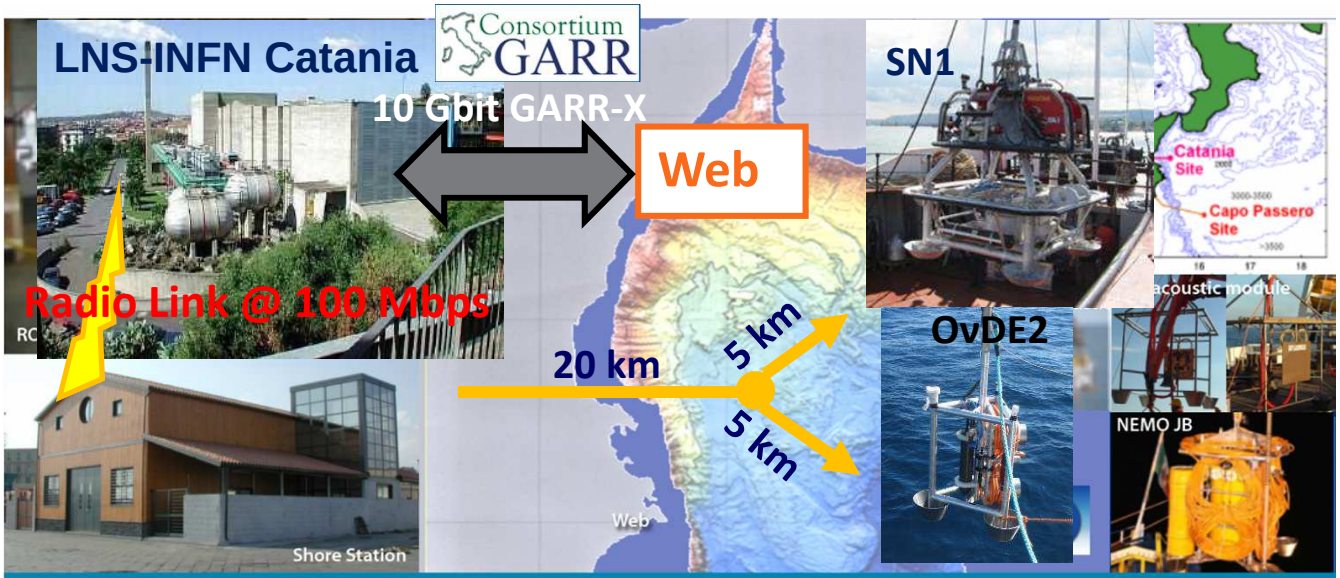

INFRASTRUCTURE NEMO-SN1 seafloor observatory, cabled to laboratory in the harbour of Catania by electro-optical cable

OPERATING IN REAL TIME SINCE 2005 Integrated with land-based networks by transmitting real- time data to National Seismological Service Centre in Rome; Test site for realisation of the underwater neutrino telescope

RESEARCH Geohazards, tsunami, climate change, bioacoustics and ambient noise.

PREVIOUS/RECENT ACTIVITIES LAMS and SIRENA FESR projects (national). GNDT-SN1 (national). PEGASO project (Structural funds). ESONET demo missions (LIDO, LIstening to the Deep Ocean environment). GENESI-DEC, SCIDIP-ES (FP7 infrastructures), KM3NET, TRANSFER

FUTURE ACTIVITIES extention of the Catania 30-km cabled; Off Capo Passero 100-km cabling, it has been operating from 2011; Further implementation adding water column and data management from 2012

WESTERN IONIAN SEA

Stand-alone 2002-2003 - Cabled 2005-2008 & 2012 real-time data

Geo-hazards
(earthquakes, tsunamis, volcanic activity)

KM3NeT

Bio-acoustics
(mammal tracking)

Oceanography
(e.g., deep water circulation, current intensity and direction, temperature, salinity)


ROV (operative 4000 m)

EMSO data examples

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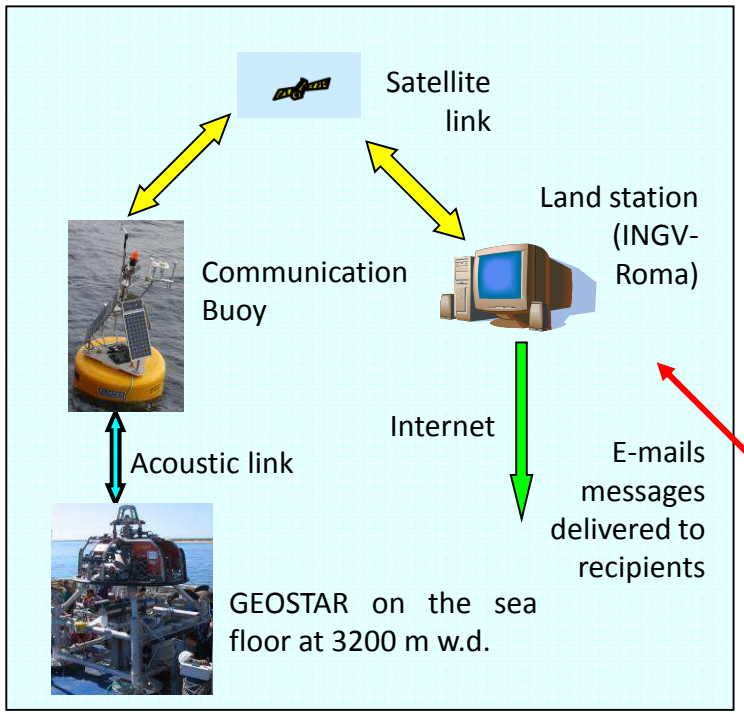
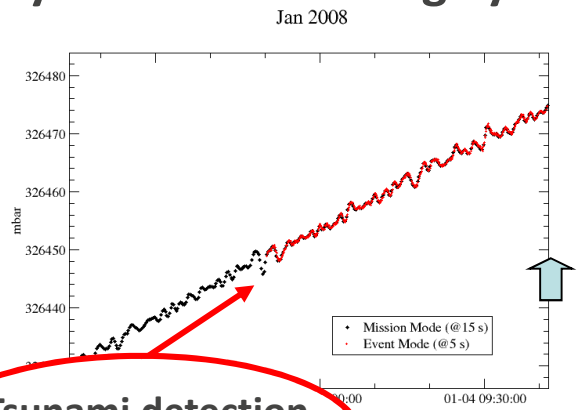


Early Tsunami Warning System

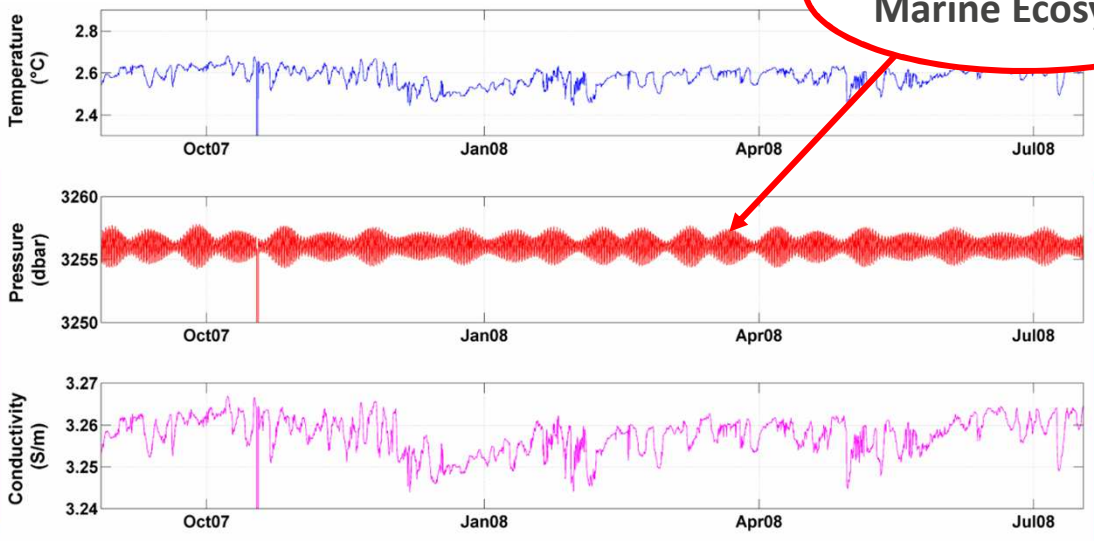


Iberian margin

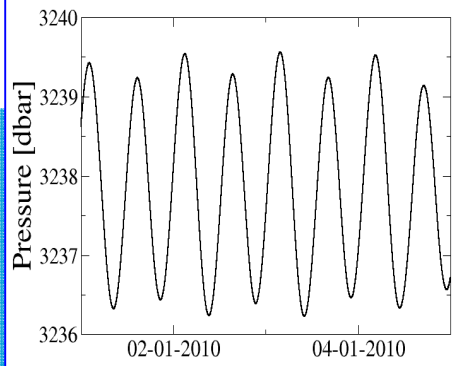
Tsunami detection system (geo-hazard)

A pressure event detected by the Tsunami Detection Algorithm (from 1° mission)

Climate Changes, Marine Ecosystem

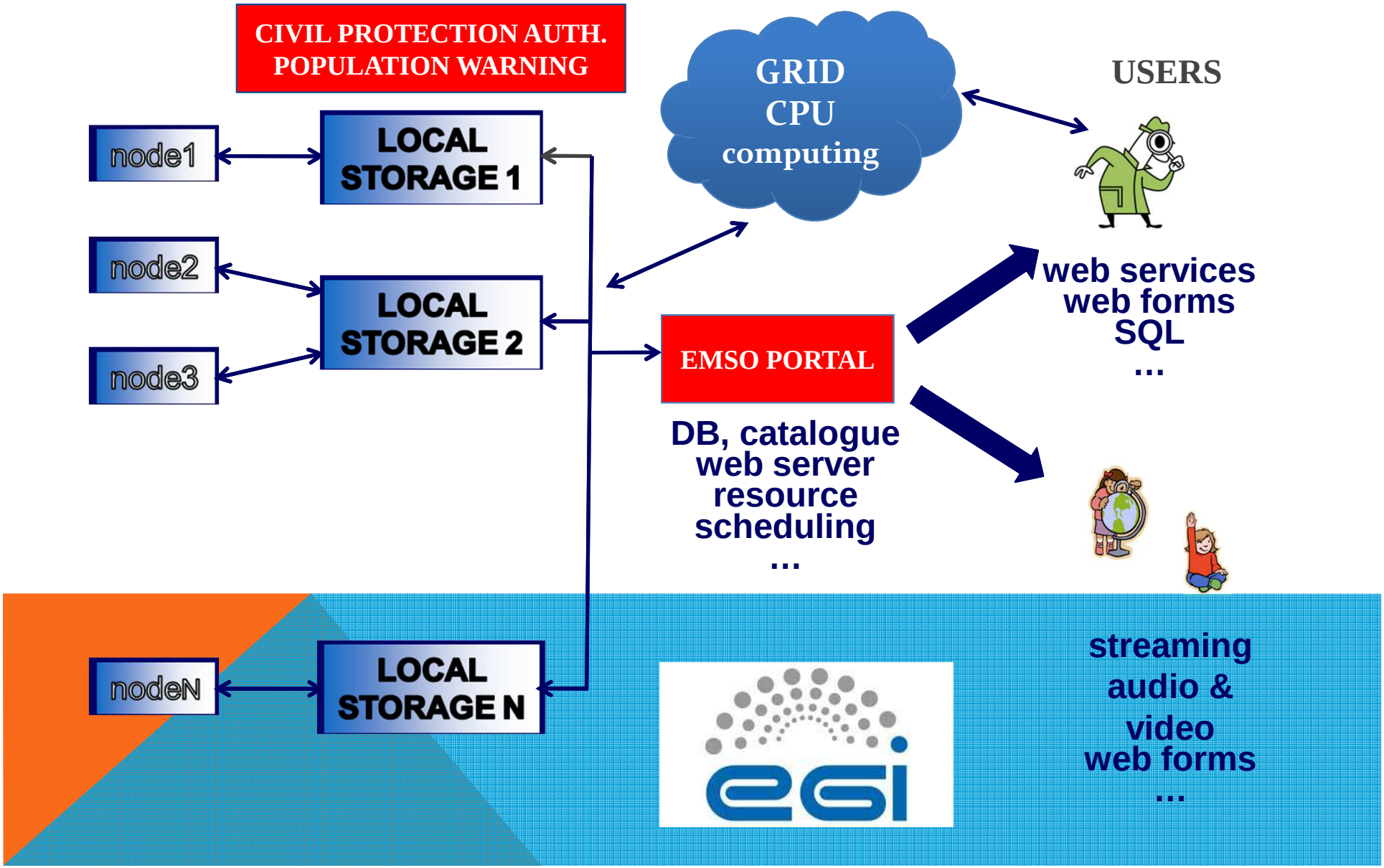


Data from 2° mission



Chierici et al., 2009; 2012

EMSO distributed storage & database



CONCLUDING REMARKS

Scientific & Societal demand for Deep Sea and Water Column

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- **Oceans are** essential to quality of life on Earth. **Largest most complex Biome on Earth- ORIGIN OF LIFE**
- **Oceans dynamics** drive most of the ecosystems on Earth, and control on the Planetary Climate

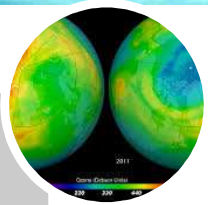
-70% of Volcanism on Earth Occurs Underwater. Source of Hazards- Often Unpredictable

- **Oceans** are the **last unexplored frontier on Earth**
-There is a **increasing exigency to understand de oceans**

EMSO AIMS: For long-term monitoring series of sub-seafloor, seafloor and water column

To study Ecosystems, Global changes, Earth Sciences and Geo-hazards and for Environment protection

Marine component of **GMES** and **GEOSS** Platform for **Data Access and management**



Earths interactions hydrosphere, biosphere, lithosphere, atmosphere

Geohazard and early warning capacity for earthquakes ,tsunamis, gas-hydrates release and submarine slope failure and sediments instability

Research and long term and continuous monitoring has the highest priorities?

Interactions between ecosystems , biodiversity, biogeochemistry physic and climate for e.g. understanding present and past climate changes in the poles?

Regular operations are needed and prioritized for research, monitoring purposes, and maintenance of permanently installed observatories, based on the previous items?

Impact of exploration and extraction of natural resources and living resources

Observation on how Natural and Anthropogenic changes Connecting scientific outcomes to stake holders and policy makers

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Thanks for your attention